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AIR CONDITIONING SYSTEMS AND METHODS

Field of the Invention

The present invention relates to air conditioning systems and methods. More specifically, the invention relates to fresh air conditioning systems and methods for both summer and winter use.

Background of the Invention

Modern homes require air conditioning, specifically, cooling in summer and heating in winter. The flow of fresh air is also necessary, in order to remove unwanted gases and odors. When the enthalpy gradient between outside and inside air is large, the flow of fresh air associated with energy consumption, for cooling in summer and heating in winter, increases. Thus, in tropical climates, where the outside air enthalpy is 90 kJ/kg and inside air is kept at 52 kJ/kg, the flow of fresh air required to exchange 1 kg of air increases the latent load by 38 kJ. Similarly, in the winter, the exchange of fresh air increases the heating load.

Disclosure of the Invention

It is thus a broad object of the present invention to provide systems and methods for fresh air conditioning of a space within an enclosure, utilizing heat and liquid exchange between fresh air flowing into the system and air exiting from the enclosure.

In accordance with the invention, there is provided an air conditioning system for conditioning the space within an enclosure having at least one inlet and one outlet, said system comprising first and second liquid/air heat exchangers; said first heat exchanger having an opening for receiving fresh air from the environment and for propelling the fresh air through said first heat exchanger to exchange heat with the liquid before it is entered into said enclosure, and said second heat exchanger having an opening for receiving air from the enclosure and for propelling it through said second heat exchanger to exchange heat with the liquid before it is expelled into the atmosphere.

The invention further provides a method for air-conditioning an enclosed space, comprising providing an air-conditioning system according to the present invention, and

precooling said liquid prior to entering same into the evaporator by utilizing cooled air from said space.

The invention still further provides a method for air-conditioning an enclosed space, comprising providing an air-conditioning system according to the present invention, and utilizing the heat pump for preconditioning the liquid passing therethrough before propelling the liquid through said heat exchangers.

The method still further provides a method for evaporation of industrial wastes according to the present invention; replenishing the reservoir of the heat exchanger receiving fresh air from the environment with liquid desiccant, and draining excess water from the reservoir of the other heat exchanger.

Brief Description of the Drawings

The invention will now be described in connection with certain preferred embodiments with reference to the following illustrative figures, so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

Fig. 1 is a schematic, cross-sectional view of an air conditioning system according to the present invention;

Figs. 2 and 3 are schematic, cross-sectional views of the system of Fig. 1, including a heat pump illustrating two possible operation modes of the system during summer conditions,

Figs. 4 and 5 are schematic, cross-sectional views of the system of Fig. 1, including a heat pump illustrating two possible operation modes of the system during winter conditions;

Fig. 6 is a schematic, cross-sectional view of the system according to the present invention, for industrial waste evaporation, and

Fig. 7 is a schematic, cross-sectional view of the system according to the present invention for utilizing a multi-way valve, enabling summer and winter operations.

Detailed Description of Preferred Embodiments

Illustrated in Fig. 1 is a preferred embodiment of the present invention, of a system 2 for air conditioning an enclosure during both summer and winter. It should be noted, however, that with minor modifications that will become apparent hereinafter, the system can be utilized for air conditioning during summer or winter, as required.

Shown in Fig. 1 is an enclosure 4, having an air conditioning inlet opening 6 and an air conditioning outlet opening 8 and defining an air-conditioned space 10. System 2 is essentially composed of two substantially similar, preferably direct-contact, heat exchangers 12, 14. Each of the heat exchangers includes a housing 16, 16′; a liquid reservoir 18, 18′; an evaporative media 20, 20′; a dripping chamber 22, 22′ interposed between the reservoir and the evaporative media; liquid outlets 24, 24′, e.g., nozzles or sprayers, and a fan 26, 26′, located above outlets 24, 24′. The fans 26, 26′ can be substituted by blowers (not shown), located at or adjacent to the fresh air inlet port 28 of heat exchanger 12 and air inlet port 28′ connected to and receiving air from the space 10.

The liquid which can be used in the system, according to the present invention, can be with water, however, it is preferred to use a liquid desiccant and specifically brine. The following description will therefore relate to brine as a non-limiting example of a liquid.

Brine from reservoirs 18, 18′ is selectively propelled by pumps 30, 30′, through conduits 32, 32’ to outlets 24, 24’ of heat exchangers 12 and 14, respectively, as is clearly indicated by the arrows. Obviously, instead of the two pumps 30, 30′, one pump

could be used. The reservoirs 18, 18′ are interconnected by conduits 34, 34′ to allow the flow of brine from one reservoir to the other, preferably by gravity. Optionally a control valve 36 is provided for controlling the flows between the reservoirs, as required.

Advantageously, system 2 also includes drift eliminators 38, 38′, interposed between brine outlets 24, 24′ and the fans 26, 26′. A humidifier 40 can also be installed in the passageway between heat exchanger 12 and the inlet 6 to space 10 within enclosure 4.

Referring now to Fig. 2, there is illustrated the system 2 of Fig. 1 adapted to improve enthalpy for ordinary summer operation. As seen, the system 2 also includes a heat pump 42, composed of an evaporator 44, a condenser 46, a refrigerant compressor 48 and an expansion valve 50, both interconnecting the evaporator 44 and condenser 46, for circulating the refrigerant in selected directions. Air from the outside is entered into the heat exchanger 12 and exchanges heat and vapor with the brine from reservoir 18′ after passing through the evaporator 44 for further cooling before entering the enclosure 4. Thus, the fresh air entering the enclosure 4 is cooler and dryer.

Referring to Fig. 3, there is illustrated the system 2 of the present invention recommended to be used during non-extreme environmental conditions. The relatively cold air exiting from the cooled space 10 is utilized to cool the condenser 46 instead of heating the evaporator 44, as in the embodiment of Fig. 2.

During winter conditions when the outside air is colder than the air inside the enclosure, the system 2 of Fig. 4 can be used. The relatively warmer brine from reservoir 18' is propelled through the condenser 46 to receive extra heat before being utilized to heat the outside air in heat exchanger 12.

A further embodiment for winter heat conditioning is shown in Fig. 5. The evaporator 44 is relatively warmer than the condenser 46 due to the warmer brine from reservoir 18' passing therethrough. The compressor 48 operates efficiently because of the low pressure gradient between the evaporator 44 and the condenser 46. The latter

heats up the fresh air entering the heat exchanger 12 before being propelled into the enclosure 4.

With minor modifications, the system 2 can also be utilized for evaporation of industrial wastes. Seen in Fig. 6 is a system 2 according to the present invention, in which the reservoir 18 is provided with an inlet port 52 for adding brine to replenish evaporation, and reservoir 18' is fitted with an outlet port 54 for draining excess water.

While in the foregoing embodiments separate flow paths have been shown between each of the reservoirs 18, 18' and the heat pump 42, reference is made to Fig. 7 showing the system 2 in which a multi-way valve 56 is provided enabling controlling the flow from each of the reservoirs to the condenser or evaporator of the heat pump 42, for efficient air-conditioning during changing environmental temperatures.

In the preferred embodiments of the invention, it is envisioned to utilize as heat exchangers 12 and 14 the liquid/air direct contact heat exchanger of the type described in the publication WO 00/11426, the teachings of which are incorporated herein by reference.

It will be evident to those skilled in the art that the invention is not limited to the details of the foregoing illustrated embodiments and that the present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.